Fermilab Independent QA Assessment Report

Assessment Number & Title: 12-QA-015TD-Design/Engineering **Version: 001**

Date(s) of Assessment: 07/16/12 – 07/20/12

Performing Organization: Office of Quality & Best Practices

Assessed Organization(s): Technical Division (TD) including the following departments:

- Test & Instrumentation (T&I) Department
- Superconducting Radio Frequency (SRF) Development Department, Cavity and Cryomodule Design & Engineering
- Magnet Systems Department, Accelerator Support
- Design & Drafting Department

As described in the respective departments Mission Statements:

The Test and Instrumentation (T&I) Department performs measurements and test of both R&D and production accelerator components, and develops technologically advanced instrumentation, control solutions, and cryo-mechanical systems for accelerator applications.

The SRF Development Department contributes to the advancement of conventional and superconducting Radio Frequency technology used in all aspects of beam acceleration, handling and detection. Work includes basic beam dynamic simulation, establishment of design requirements, engineering specifications, design and engineering to develop 'build-to-print' packages for procurement, development of prototypes, definition of work process control procedures, development of inspection criteria and fabrication procedures, and providing fabrication and production oversight.

The Magnet Systems Department provides support for the Fermilab Accelerator complex by repairing or refurbishing existing accelerator components and designing, fabricating and providing testing oversight of new devices for improvements to the accelerator complex.

The Design and Drafting Department is responsible for project design and drafting activities, both within the Division, and for outside 'customers'. Development of component, assembly, and system designs is a key goal of the department. The Department has document control of all drawings, files, specifications, parts lists, releases, and change orders.

Assessment Activities & Scope:

Implementation and effectiveness of design and engineering as described in IQA Chapter 6 and Fermilab Engineering Manual were examined via interview, observation, and document review.

Scope Limitations:

Procurement activities and software are excluded from this assessment.

Activities Reviewed Within this Assessment:

- Engineering Management
- Mechanical Engineering
- Cryogenic Engineering
- Design & Drafting

Description of the Implementation & Effectiveness of Observed Activities:

Design & Engineering

The requirements of IQA Chapter 6, Design, are met and are effectively implemented within Technical Division. The assessment concentrated on the lead engineers since they are responsible for ensuring that the design meets project specifications, for organizing project documentation, and that all engineering is performed according to the provisions of the Engineering Manual. Engineers are responsible for following the provisions of the Engineering Manual and for fulfilling additional TD requirements. Department Heads are directly responsible for performing the risk assessment using the graded approach to determine and implement the proper level of formality for a project.

Four TD projects were evaluated:

- NUMI Offaxis electron neutrino (ν) Appearance (NOνA), RF Cavity Tuning Solenoid
- Project X Injector Experiment (PXIE), SSR1 Cryomodule
- PXIE, 325 MHz Spoke Resonator Cavity
- Muon Ionization Cooling Experiment (MICE) Test Stand

Discussion with the lead engineers and evaluation of documentation (File01 – File07) confirmed that all four projects developed engineering specifications and performed risk assessments as specified in the Fermilab Engineering Manual, Chapters 1 & 2. Both PXIE projects shared the same Risk Assessment file. Fermilab Risk Assessment Spreadsheet was used to perform the risk assessment (File05 – File07). The MICE test stand specification was also written in accordance with TID-N-59, Engineering Work Process Guidelines, Test and Instrumentation Department, Rev. No. 0.

Interviews with lead & project engineers confirmed that engineering specifications are being reviewed. Engineering specification reviews were documented (File08 & File09) as identified in Chapter 3 of the Fermilab Engineering Manual.

Interview and observation with the Drafting and Design Department Head verified that the Fermilab drafting standard is ASME: Y14.5. Drawings for the RF Cavity Tuning Solenoid project are in Teamcenter9. Drawings for the MICE Test Stand are in I-DEAS (Integrated Design and Engineering Analysis Software). Both Teamcenter9 and I-DEAS are database management tools used for Product Lifecycle Management (PLM). There is an effort underway at Fermilab to migrate all science/engineering project documentation from I-DEAS to Teamcenter9.

Drawings for the MICE Test Stand are assigned numbers as identified in the Fermilab Engineering Manual, System Design Appendix. Drawings for RF Cavity Tuning Solenoid project are assigned numbers in Teamcenter9 format, a simpler truncated numbering scheme loosely based on the System Design Appendix. Direct observation of the engineering drawings and discussion with the department head confirmed that drawings are reviewed by a qualified person other than the drawings originator, and changes are tracked on each version of the drawings. The engineering drawings reviewed by the team (Appendix 1) meet the requirements of the Engineering Manual, Chapter 4.

Calculations are self-checked by the engineer performing the calculation before being sent for peer review, which is good engineering practice, and was observed during all interviews. Engineering calculation requirements of the Engineering Manual, Chapter 4, is effectively implemented.

Talks with the engineering leads and examination of the documentation requirements in Chapter 5 of the Engineering Manual, Engineering Design Review, corroborated that Engineering Design Reviews were performed, are scheduled or planned (no date set at the time of the assessment).

- NOvA, RF Cavity Tuning Solenoid, is scheduled for 8/13/2012, File10
- PXIE, SSR1 Cryomodule, too early in project to schedule a review
- PXIE, 325 MHz Spoke Resonator Cavity, is scheduled for September 2012
- MICE Test Stand, Preliminary Design and P&ID reviews completed and documented (File07 & File11), System Integration and safety review not yet scheduled.

The MICE test stand Preliminary Design and P&ID reviews were performed in accordance with TID-N-59, Engineering Work Process Guidelines.

Conversation with the lead and project engineers identified that the it was far too early in the project schedule to review Testing and Validation, Release to Operations and Final Documentation requirements for the four projects, as specified in Chapters 7, 8 and 9 of the Engineering Manual.

The engineers interviewed are aware of the Configuration Management Plan (CMP) and engineering baseline requirements identified in Chapter 6 of the IQA. An engineering baseline was established for the MICE Test Stand, File12. Engineering baselines will be established for the two PXIE projects, referencing either the Lattice 1 sequence & spacing within the accelerator, or with the engineering specification. No decision was made at the time of this assessment. It was too early in the project schedule to establish the baseline for the NO*v*A, RF Cavity Tuning Solenoid.

Discussion with the lead engineers revealed that a CMP will be developed for the MICE test stand after the test stand is repurposed. Due to small project size (4 coils to be fabricated) small budget ($60k), use existing technology and design simplicity, a CMP is not necessary for the NO*v*A, RF Cavity Tuning Solenoid.

Conclusions:

Design controls identified in IQA chapter 6 and the engineering requirements of the Fermilab Engineering Manual through chapter 6 are being followed. Review of engineering specifications, risk assessments, drawings, documents and reports show compliance with the requirements. Furthermore, individuals interviewed have vast technical knowledge and understand the requirements of the Fermilab Engineering Manual.

Findings:

1. None

Observations and Recommendations:

1. **Observation:** PXIE SSR1 Cryomodule Engineering specification was reviewed at two "Tuesday Morning" project meetings but not properly documented. The Fermilab Engineering Manual,

Chapter 3, Requirements and Specification Review, states that project review documentation includes, at a minimum, a meeting summary describing who attended the review, what issues they discussed, what deficiencies they identified and what recommendations they made.
Recommendation: Going forward ensure that all specification reviews are documented in accordance with Fermilab Engineering Manual, Chapter 3.

2. **Observation:** PXIE SSR1 Cryomodule and 325 MHz Spoke Resonator project personnel were not aware if a Project X CMP included the requirements of these two projects.
Recommendation: Determine if Project X CMP includes the requirements of the SSR1 Cryomodule and 325 MHz Spoke Resonator. If not, revise Project X CMP to include the requirements or create a CMP for these projects.

Commendable Practices:

1. None

Persons Interviewed:

- Alexander Makarov
- Vladimir Kashikhin
- Tom Nicol
- Leonardo Ristori
- Iouri Terechkine
- Ruben Carcagno
- Cosmore Sylvester
- Don Mitchell

Documents Reviewed:

- Fermilab Engineering Manual, Version No. 7/10
- Fermilab Risk Assessment Spreadsheet (12/9/2010)
- TID-N-59, Engineering Work Process Guidelines, Test and Instrumentation Department, Rev. No. 0

Attachments:

- File01, Kashikhin_NOVARFCavityTuner_051512.docx
- File02, ssr1_cm_functional_requirements_specification_v4.pdf
- File03, FRS 325 MHz SSR1 Cavity_rev-noneSigned.docx
- File04, 2241.docx
- File05, 2012-RFSOL_Risk_Assessment.xlsx
- File06, SSR1 Cryomodule for PXIE - risk assessment - v2.xlsx
- File07, 2226.xlsx
- File08, approval-solenoid.pdf
- File09, 2227.docx
- File10, 20120711_Schedule
- File11, 2321.pdf
- File12, 2191.docx

Standards, Regulations, and Other Program Requirements Applied:

The specific criteria applied to this assessment were:

1001 Fermilab Integrated Quality Assurance (IQA) revision 2, Chapter 6 – Design

Corrective Action Plans Issued:

None

Assessors' Names (asterisk indicates team leader):

- Michael Pakan* - OQBP
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- John Martzel – OQBP

Submitted by: Michael Pakan **Date:** 8/14/12

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Appendix 1:

Engineering Drawings Reviewed:

F10001083	BOTTOM SLIDING PLATE	Rev: -
F10001084	TOP SLIDING PLATE	Rev: -
F10001085	SOLENOID WINDING TOOLING ASSY	Rev: -
3973.340-MB-484280	MU2E – MAGNETS MICE COUPLING COIL SHELL HELIUM DEWAR HEATER VESSEL	Rev: A
3973.340-MB-484284	MU2E – MAGNETS MICE COUPLING COIL SHELL VACUUM CAN HEATER VESSEL	Rev: B
3973.340-MD-484309	MU2E – MAGNETS MICE COUPLING COIL HEATER VESSEL ASSEMBLY	Rev: B